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As is well warranted by its importance, a separate chapter is devoted to the composition and utilization of molasses; Java-molasses, to the study of which the author has given much time and personal attention, receives specific consideration.

The final section of the book deals with factory-output, calculations and records; extensive tables and a satisfactory index conclude the volume.

This brief outline of the book's contents will indicate in how thorough and painstaking a manner the author has acquitted himself of his self-appointed task. His familiarity with the work of other investigators, with that of his American confrères among others, is amply attested by foot-notes and references scattered throughout the volume.

The straightforward, lucid style in which this book is written is characteristic of its author and makes its reading a pleasure, nor must the excellent make-up of the publication pass unnoticed—the quality of paper used, its typography, the marginal indices, all certainly merit the appreciation of its readers.

F. G. WIECHMANN

An Introduction to the Lie Theory of One-Parameter Groups, with applications to the solution of differential equations. By ABRAHAM COHEN, Ph.D., Associate in Mathematics, Johns Hopkins University. Boston, D. C. Heath & Co. 1911. Pp. iv + 248. Half leather.

The scope of this attractive little volume may be inferred from its seven chapter headings, which are as follows: Lie's theory of one-parameter groups, differential equations of the first order, miscellaneous theorems and geometrical applications, differential equations of the second and higher orders, linear partial differential equations of the first order, ordinary differential equations of the second order and contact transformations.

In form, binding and paper the present volume is similar to the "Elementary Treatise on Differential Equations," by the same author, published in 1906. In subject matter it forms a suitable sequel to this work, but it can be read with a more limited knowledge of differential equations. While it should appeal especially to the student of mathematics who is about to begin graduate work in an American university, it should also prove useful to those who make frequent use of the differential equation in applied fields of mathematics and who desire to look at the subject from the systematizing and clarifying standpoint of group theory.

The book closes with an appendix containing seven notes, two tables, answers to the examples, and a good index. In these notes several important subjects are developed for which there was no room in the body of the book. In particular, the n-parameter group of transformations is considered briefly in one of these notes. The two tables contain forms of differential equations of the first and of higher order which are invariant under known groups.

It is very gratifying to witness the rapid increase of American mathematical literature suitable for students who are just beginning graduate work. Even very good students of mathematics have found the transition period from undergraduate to graduate work discouragingly difficult because they were all at once compelled to use foreign literature with an abrupt change of point of view and method of presentation. During the last decade much has been done to remedy this serious drawback, but there are still many lacunas in this literature. The present volume has reduced by one the number of the most important of these.

G. A. MILLER

SPECIAL ARTICLES

CARBON DIOXIDE AT HIGH PRESSURE AND THE ARTIFICIAL RIPENING OF PERSIMMONS

IT is already known from the work of Prinsen-Geerligs (through Gore, 1910) on the fruit of the banana that its astringency disappears, without softening of the pulp (mesocarp), when surrounded by an atmosphere deprived of oxygen. This result suggested to

Gore, of the Bureau of Chemistry, U. S. Department of Agriculture, that the use of any "inert" gas would be equally efficient, and accordingly he tried the effect of carbon dioxide (Gore, 1910, 1911). The outcome of his experiments, as of my own (Lloyd, 1911) is to show that the results of Japanese method of processing, a procedure, apparently empirical, of exposing the fruit to the fumes of sake by packing in recently emptied casks, may be duplicated. Indeed, according to Fairchild (1905, 1911), attempts on a limited scale to imitate the Japanese method in this country, had already met with success, so that there could have been little doubt in the minds of those cognizant of the facts that, with effort, but a short time need intervene before a method could be worked out for attaining, even on a practical scale, the results desired. The expectation must have been strengthened by the results obtained by Vinson (1909) on the date (*Phœnix dactylifera*) whose fruit possesses, as regards the tannin cells, cytological characters precisely similar to those of the persimmon, sapodilla and other, doubtless numerous, fruits. Vinson found that acetic acid fumes can be used for processing dates to prepare them for the market, the immediate and important outcome being the loss of astringency. He (Vinson, 1910) further found that a host of reagents of the same phase can be used, but with attendant results undesirable from an economic point of view. Of these, for a single example, nitrous ether affects the tannin cells in such a manner that the contained tannin is no longer free to enter into solution, and hence the non-astringency. Even heat may be used to hasten the result, as Vinson (1907, 1910, 1911) also showed, while Freeman (1911) extended the use of this discovery in a practical way.

In order to describe the loss of astringency, it was stated jointly by Bigelow, Gore and Howard (1906) and later by Vinson (1907) that the tannin in the persimmon becomes "insoluble" during the ripening process. But, as I have shown, "insoluble" tannin is not otherwise known. To use the adjective quoted is to contravene the accepted definitions of the substance therewith described. Indeed, the astonishing unusualness of the conception appears when it is realized that there is known no compound of tannin with organic products, composing "leather" of one form or another, which, by repeated contact with fresh solvent, will not give up fractions of the amount of tannin originally bound up with the associated substance. Analogies in the field of colloidal chemistry will immediately occur to those even only slightly initiated into its mysteries, for such they surely are at the present moment. My own work begun on the date (1910) in 1907 and continued on the persimmon (1911, *a* and *b*) and sapodilla (1911, *b*) has enabled me to throw some light on the difficulty. I have shown that, during the process of ripening, the loss of astringency is due to the union of the tannin with an associated colloid (1911, *a*) of carbohydrate nature (1911, *b*), which is an intraprotoplastic product in common with the tannin itself, and which undergoes a gradual coagulation as seen in its increasing firmness and loss of swelling capacity. During this process the tannin becomes adsorbed, and there is thus formed a vegetable leather, from which only exceedingly small fractions may be extracted by ordinary solvents (water, alcohol), but which may be attacked chemically and then extracted by means of strong nitric acid, leaving the entire, or nearly the entire amount of the associated colloid intact (Lloyd, 1911, *c*). We may thus obtain this as yet practically unknown body for examination by chemical methods, which have already yielded some important results, indicating as above noted its carbohydrate nature.

So that it develops that the essential fact of the loss of astringency is the formation of a colloidal complex, of which tannin is one, and another carbohydrate the other member. Disregarding those reagents which have a chemical effect upon the tannin itself (so far as we can determine this) there is a number of substances which are capable of hastening this process. Alcohol and acetic acid vapors (the possible chemical effect of the latter on

tannin being disregarded for the moment) do so, but the change is accompanied by other autolytic processes, in equal rates, which cause the digestion of the middle lamella, and, probably, conversion of sugars and of aromatic substances. Carbon dioxide, however, is peculiar in that the loss of astringency is materially hastened while, relatively, the remaining changes are held in abeyance, being, however, hastened as compared with normal conditions. Herein lies the secret of the Japanese process, the source of the carbon dioxide being the fruit itself, as a result of respiration. As Gore (1910, 1911) showed, a pure atmosphere of carbon dioxide, making available a larger amount, may be used. I have repeated his experiments with the goal of immediate practicality in view, and have succeeded in perfectly processing two varieties of Japanese persimmons (*Taber 129* and *Hyakume*) in churn barrels on a scale sufficiently large to demonstrate the feasibility and low cost of the method for the grower or merchant. The mechanical features of the churn barrel (of the "Daisy" churn) permit the easy packing of the fruit in suitable material and the lid may be made sufficiently tight to imprison the carbon dioxide for the period necessary without recharging. The details of the method will appear in another form later. But this is not all, nor the most important feature of this work. I have further demonstrated that, *under increased pressure of carbon dioxid, the processing is hastened,* so that, with a pressure of 15 pounds the time required may be reduced from six to seven days, the time required under normal pressure, to less than two days. The definiteness of the experiment on this score leaves so little to be desired that I venture to detail it. Six dozen fruits, of the two varieties mentioned in nearly equal numbers, were introduced into an autoclave (The Eclipse Sterilizer) at 4 P.M., November 16. No packing was used, the fruits being placed side by side on cardboard trays. The air in the autoclave was first displaced, after which the pressure was increased to 15 pounds. A somewhat sudden lowering of the pressure from 15 to 14 pounds was attributed to the penetration of the gas into the fruit, and, at the expiration of 20 minutes, the pressure was again raised to 15 pounds. During the night, however, the pressure fell to normal, and, after recharging, the safety valve was found to leak. After adjustment the pressure remained close to 15 pounds. At 5 P.M. the same day, the pressure was raised to 18 pounds, but it fell during the night to 17 pounds, falling to 15 pounds by 2 P.M. The autoclave was then opened, and the fruit tested. The fruits examined, in all about three dozen, by various persons, were found completely processed, save that, up to date, one particularly hard and light-colored fruit was found very slightly astringent. By way of further practical test, a dish of the fruit was served to a number of guests at my home on the night of the same day, and they all found the fruit very hard, sweet and delightfully aromatic.

Fruits of the same lot, but processed two weeks previously, yielded to the treatment under normal pressure in seven to eight days. The control experiment, in which fruits of the same lot were exposed to normal pressure in a churn barrel, yielded in 8 to 10 days.

It should not be overlooked that this surprisingly short period of two days may be too brief for fruit which has just been harvested, and may vary also with the time at which the harvesting takes place. In any event, however, as the control shows, the time involved will be materially shortened with increase of pressure in the amount already indicated.

The above experience leads us to infer that, if the initial pressure had been constantly maintained, the completion of the process might have been still further hastened, while it is possible that still higher pressures may be correspondingly more efficient. Setting this aside, since there are a number of questions regarding color, degree of maturity and the like, in their relations to the rate and agents of processing which must be further studied, there is no doubt that the method of making use of supranormal pressures of carbon dioxid may be employed to an advantage

superior to that of normal pressure. The somewhat increased cost necessitated by a tight receiver is more than offset by the reduced time involved, by the certainty of the results and by the immediate availability. A suitable receiver of heavy galvanized iron similar to a kind already on the market, can be manufactured at a reasonable cost.

But the practical value of this result is no greater than its theoretical bearing. It appears, in the first place, that the rôle of carbon dioxid is not associated with its inertness, but is, on the contrary, positive, a conclusion demanded, I believe, by the time relations. How this view may be harmonized by the remaining heterogeneous mass of facts, at present available through the efforts of the abovementioned workers, it is too early to say, but it will prove, I believe, a fruitful suggestion that the explanations demanded are to be found in the relation of the heterogeneous reagents to the colloids, and therefore in the colloidal-chemical reactions, rather than in the better understood chemical relations. One may not overlook the capital fact that other of the ripening processes are hastened by carbon dioxid, but in different degrees, suggesting the effect of a general catalytic agent. An exception, however, is to be noted in the cessation of color changes. A fruit, which is yellow when subjected to carbon dioxid, does not subsequently change to the usual deep orange of the normally ripened.

From my study of the tannin cells themselves it emerges that the increase in rigidity of the tannin-masses, a slow process under ordinary conditions, is hastened under normal, and still more under supranormal pressures of carbon dioxid, but is *preceded*, by a relatively brief period, *by the completion of non-astringency*. From this it may, for the present, be inferred that the disappearance of soluble tannin is connected with the coagulation of the associated colloid, and that the rôle of the acid, carbon dioxid, is, directly or indirectly, the cause of this coagulation which proceeds up to some, at present, unknown limit at a rate related to the amount of acid available. That, by coagulation, the physico-chemical condition of the colloid, and its consequent behavior toward tannin, may be changed finds an analogy, perhaps not too loose for my purpose, in the behavior of the micropylar colloid stopping the micropyle in the egg of *Fundulus*. According to the view of Jacques Loeb (1911) this colloid becomes "tanned" in the course of one or two days if in the surrounding water certain salts are present, thereby rendering the micropylar plug semi-permeable to sodium chloride, and so preventing the toxic effect of this salt upon the embryo within.

But whatever the importance of the explanation of the phenomena in the moribund fruit, the physiological meaning of the associated colloid during its period of development is certainly not of less. It is known that the coagulation of casein by HCl may be prevented by the association, with the casein, of another, a "protective," colloid (Alexander, 1910). On the strength of this fact, Alexander has been able to throw an important light on the digestibility of human, as compared with bovine and certain other milks. It seems not improbable that, in the growing cell, such is the relation of its associated colloid to the tannin, thus preventing its attack upon the protoplasm. This, as a working theory, has a not inconsiderable tentative value. In harmony therewith is the fact that the tannin in the persimmon, as in the date, always remains within the cell, the tannin-idioplast, in which it originates (Lloyd, 1910, 1911).

Concerning the action of heat, which, it has already been said, causes coagulation of the associated colloid, Vinson, cited above, has shown that too high temperatures, sufficient to destroy enzymes, prevent normal ripening (that is, as related to astringency), while suitable temperatures, yet fatal to protoplasm, hasten it. He sees in these facts evidence of the presence of enzymes. I have shown that high temperatures (that of the boiling of concentrated cane-sugar solution) actually coagulate the associated colloid (1911), but without the complete imprisonment within it of the tannin. It seems clear from this that the time

relation is an important one, and that, during normal ripening, an enzymatic agent is at work effecting the coagulation. If this be true, the rôle of carbon dioxid may be less direct than above indicated, and that its business lies in hastening the secretion or the activity of the responsible enzyme.

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FUNDULUS AND FRESH WATER

In a series of papers[1] published in 1906 and 1907, I presented the results of experiments in which fishes of a number of species (particularly *Fundulus heteroclitus*) had been subjected to various modifications of the salt content of the containing water and to various other abnormal conditions. Contrary to the previously published statements of Loeb[2] and of Garrey,[3] I found that in the great majority

[1] *Biological Bulletin,* May, 1906; Bulletin of the Bureau of Fisheries for 1905 (May, 1906); *American Journal of Physiology,* June, 1907. Further data were reported in a paper before the seventh International Zoological Congress in 1907 (to be published).

[2] *American Journal of Physiology,* Vol. 3, 1900, pp. 327–338. I regret to say that my criticism of this writer was framed in language which, though not intended offensively, I now recognize to have been in poor taste.

[3] *Biological Bulletin,* Vol. VIII., 1905, pp. 257–270.